Exploring automated formant analysis for comparative variationist study of Heritage Cantonese and English

CVC VIII
CHANGE AND VARIATION IN CANADA
CHANGEMENT ET VARIATION AU CANADA
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HERITAGE LANGUAGE VARIATION AND CHANGE IN TORONTO
HTTP://PROJECTS.CHASS.UTORONTO.CA/NGN/HLVC

Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada

UNIVERSITY OF TORONTO

What is the HLVC Project?

- Large-scale project investigating language use and change in heritage (non-official) languages spoken in Toronto.
- Goals
  - To **document and describe heritage languages** spoken by immigrants and 2 generations of their descendants
  - To **create a corpus** available for research on language change
  - To **push variationist research beyond its monolingually-oriented core** by focusing on heritage language use among multilingual speakers
  - To develop a framework for research on heritage languages and contact

A Sample of Previous HLVC Work

	Cantonese	Faetar	Italian	Korean	Russian	Ukrainian
VOT	✓		✓	✓	✓	✓
Ø-subject	✓	✓	✓		✓	
Borrowing		✓				
Vowels	*					

* This presentation

Vowels

- Very well researched in sociolinguistics, but very little work on vowel variation and change in languages other than English.
- Large body of research has made possible the development of new technologies/techniques to make vowel analysis easier
  - Example: FAVE (Rosenfelder et al 2011)

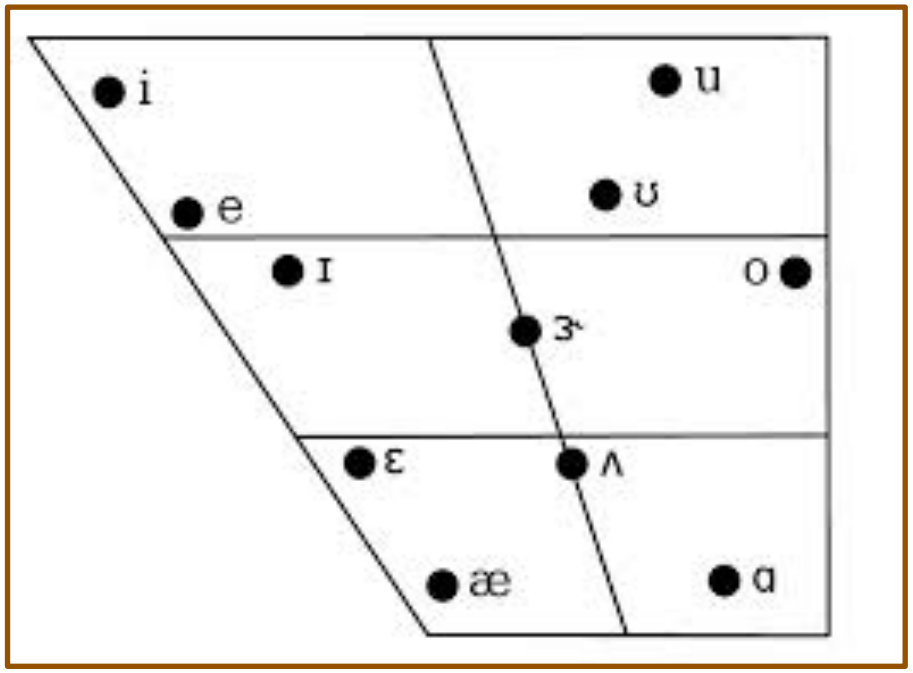


Image from Wikipedia

Goals of Current Project

- To determine the extent to which the vowel systems of Cantonese and English may be mutually influencing each other in Toronto
- To extend the use of automated forced alignment and formant extraction as tools for the sociolinguistic study of contact-induced change in Heritage Cantonese.
  - Prosodylab-Aligner (Gorman et al 2011) to be adopted

Methodological Problems

- Large amount of data in HLVC Corpus (~40 speakers/language)
  - Manual formant measurements take a lot of time.
- FAVE designed to work only on English
- Could Prosodylab-Aligner be a viable alternative?

Italian

Chinese

Cantonese

Punjabi

Portuguese

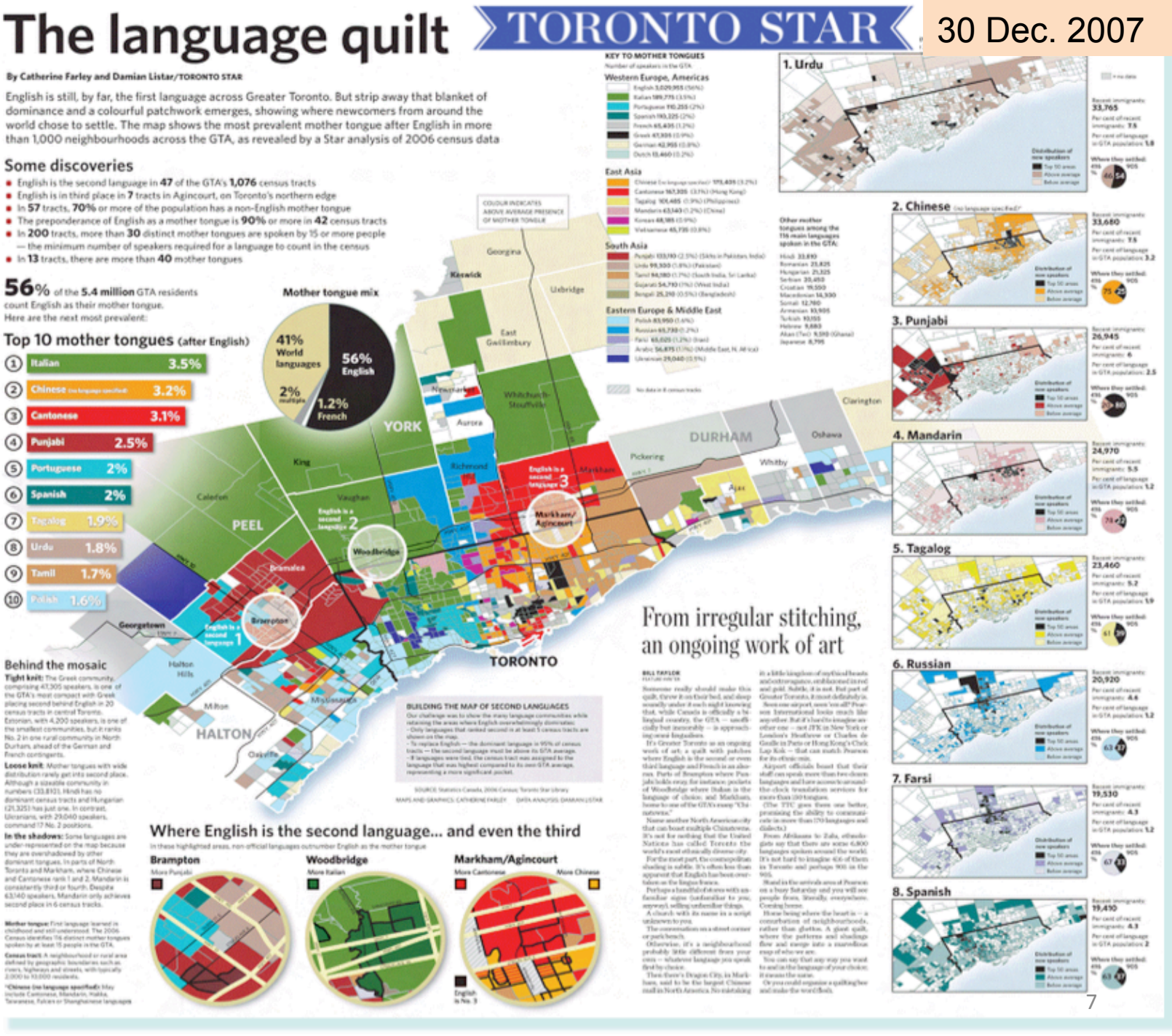
Spanish

Tagalog

Urdu

Tamil

Polish

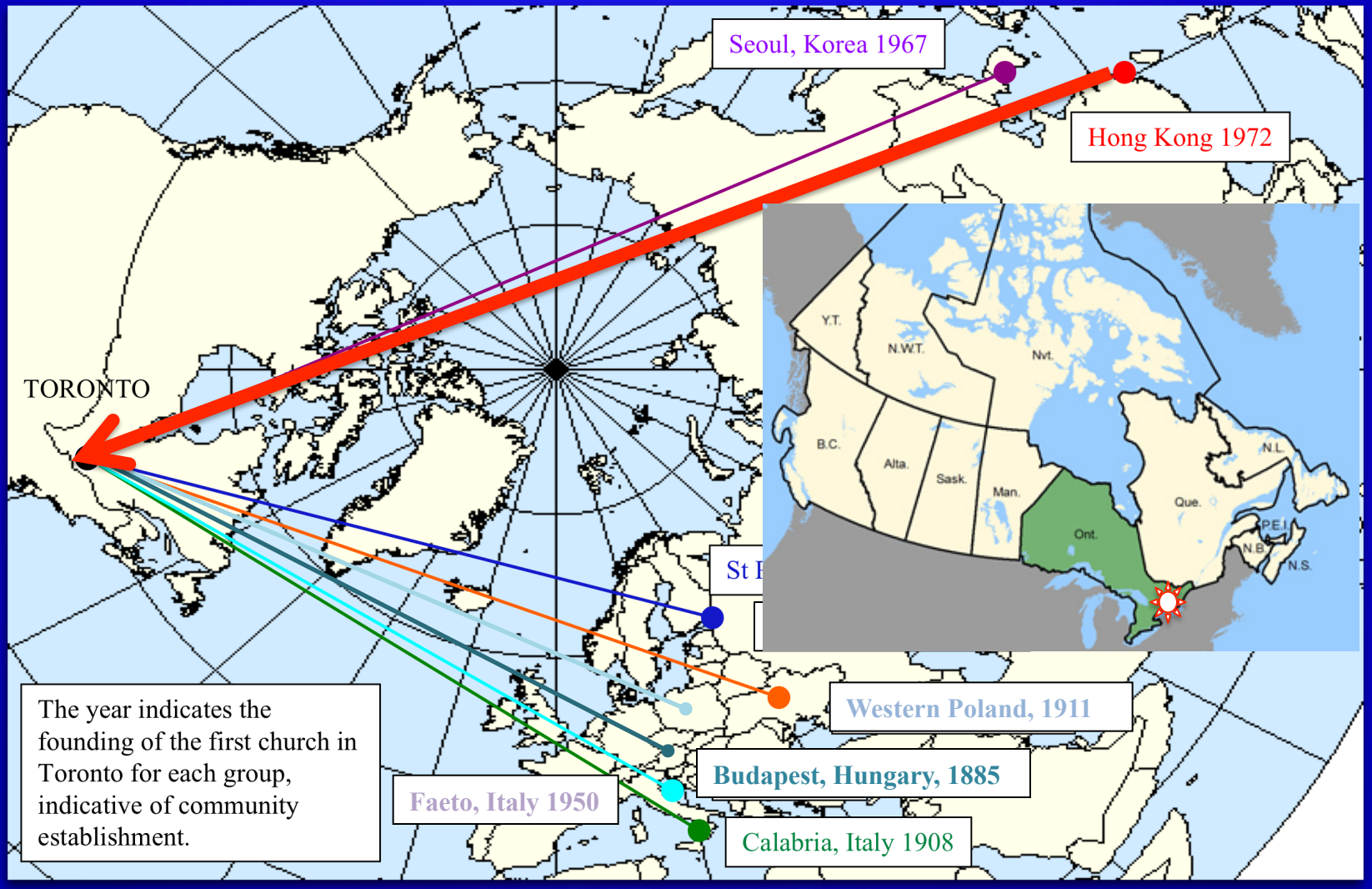


Contrasting demographics

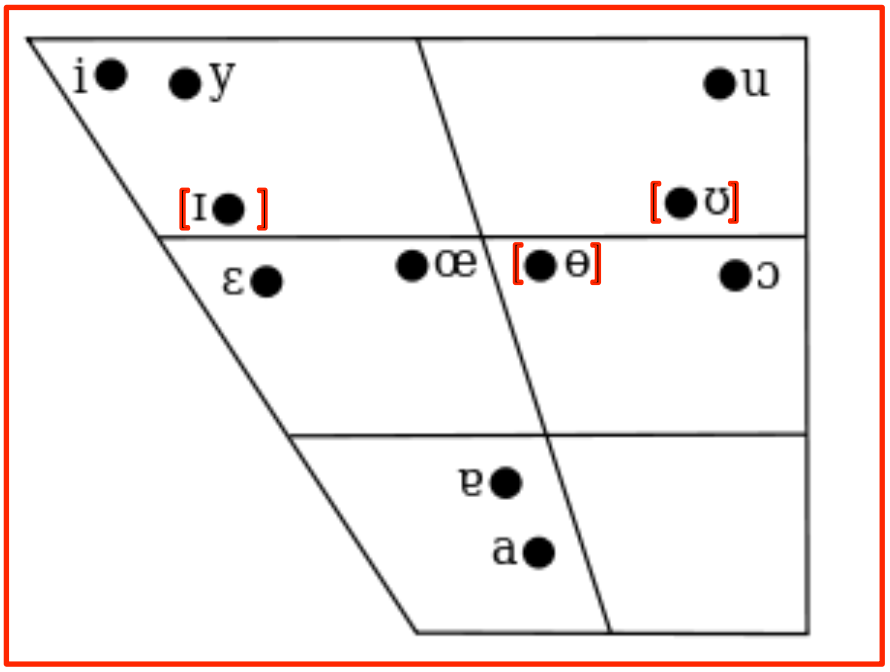
Language	MT speakers (2011 Census)	Ethnic Origin (2006 Census)	Est. in TO	Speakers come from
Cantonese	170,000+	537,000	1951	Hong Kong
Italian	166,000	466,000	1908	Calabria
Russian	78,000	58,505	1916	St. Petersburg, Moscow
Korean	51,000	55,000	1967	Seoul
Ukrainian	26,000	122,000	1913	Lviv
Faetar	<100?	300?	1950	Faeto, Celle di St. Vito (Apulia Italy)

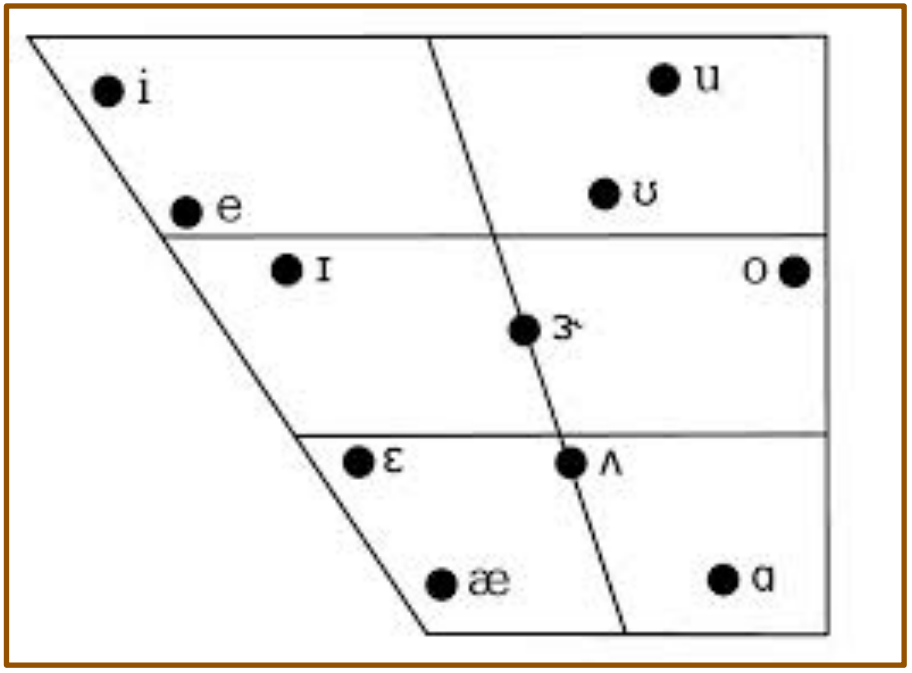
www40.statcan.ca/l01/cst01/demo12c-eng.htm;
www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E

Heritage Language Variation and Change



Cantonese vs. English Vowel Space





Images from Wikipedia

Allophonic lowering of /i/ before velars (Yue-Hashimoto 1972)

si1, /si1/, 詩, 'poem'

sik1, [sɪk1], 識, 'to know'

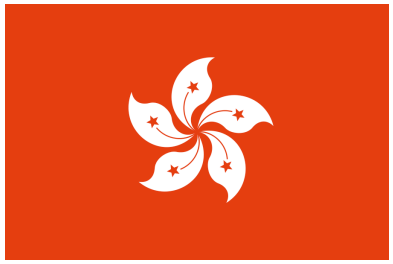
Similar Canadian English Vowels

see, /si/

sick, /sɪk/

???

Expected outcome



1st

2nd

Heritage Language / Culture

English/Canadian

Data

- Two sets of hour-long sociolinguistic interviews from 2 generations of speakers identified as Hong Kong Chinese and who claim Cantonese as a heritage language
  - Not from the same speakers, however.

Interviews in English from the Contact in the City Corpus (CinC) (Hoffman and Walker 2010)

Interviews in Cantonese from the HLVC Corpus (Nagy 2009, 2011)

"My parents came to Toronto in 1972."

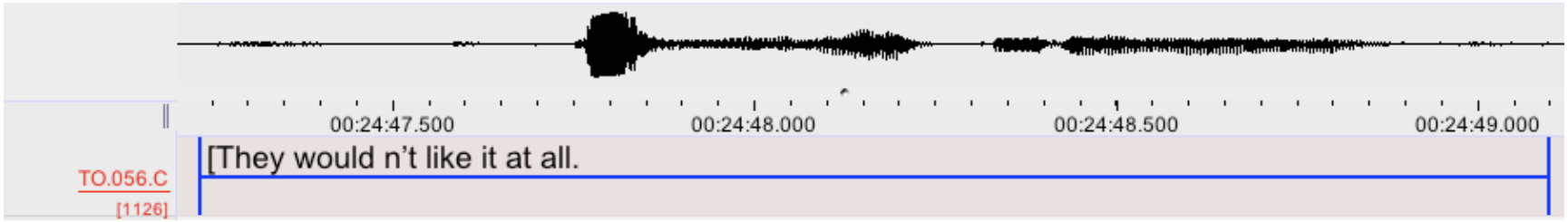
"Ngo5 fu6 mou5 yat1 gau2 cat1 yi6 lin4 lei4 dou3 do1 leon1 do1."

Speaker Sample

Generation	Sex	CANTONESE	ENGLISH
1 (Ages: 42-82)	Male	C1M62A C1M59A	TO.035 TO.038
	Female	C1F78A C1F54A C1F82A	TO.030 TO.037 TO.039
2 (Ages: 16-44)	Male	C2M44A	TO.029
	Female	C2F16A C2F21B	TO.031 TO.056
Total		N=8	N=8

Methods - English Data

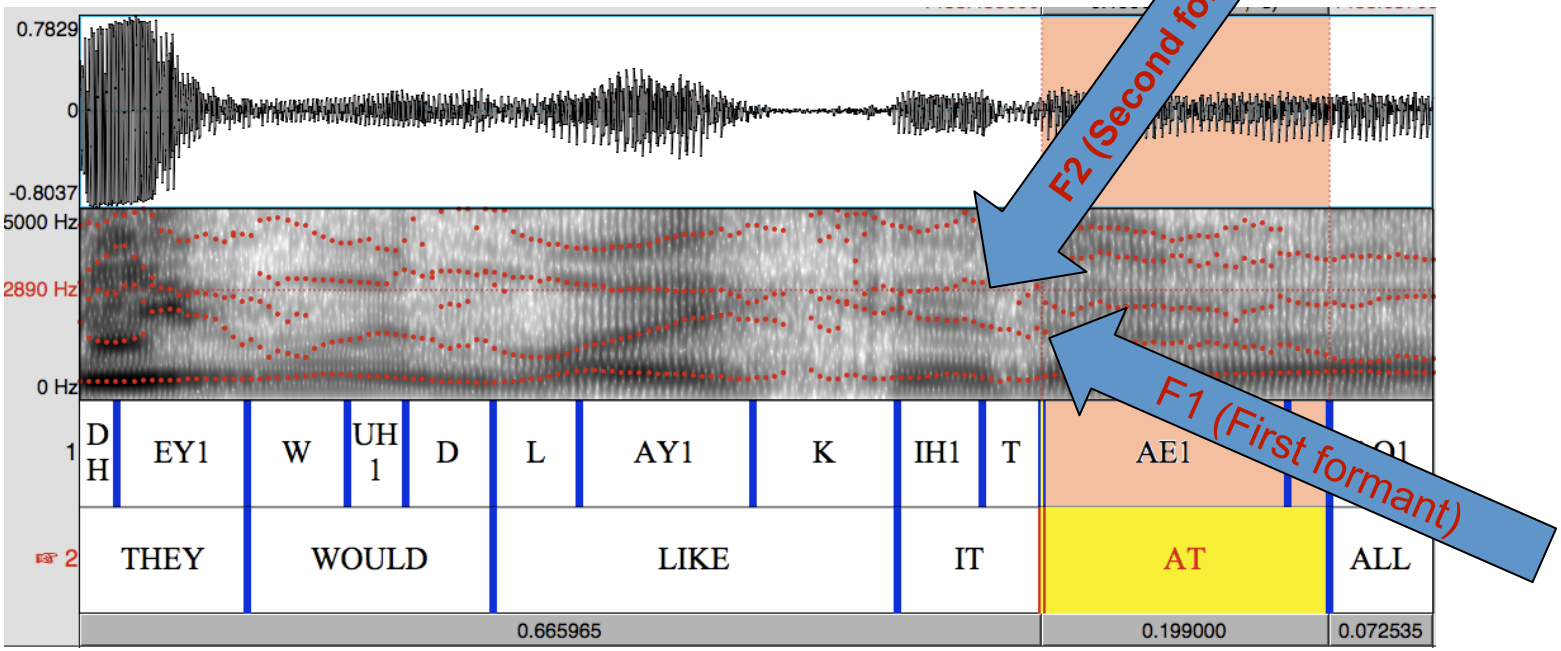
1. Sentence-level time alignment (manual) using ELAN



2. Word- and phoneme-level time alignment (automated) with FAVE
   - http://fave.ling.upenn.edu

Forced Alignment & Vowel Extraction (FAVE)

An online suite for automatic vowel analysis

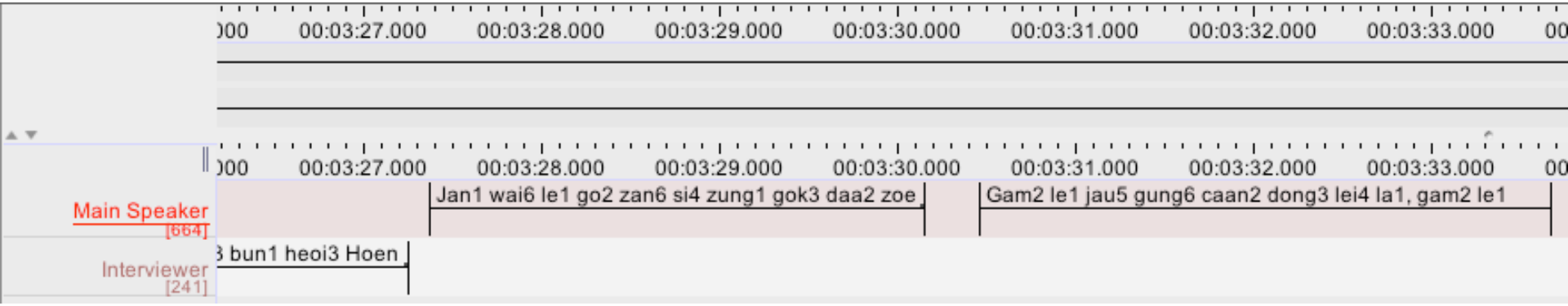


Prosodylab-Aligner (Gorman 2011 et al)

- A Python script used to perform text to audio speech alignment
- Supports training on arbitrary data
  - → With any input from language X, can be trained to deal with acoustic data from language X
- Requirements
  - At least a total of one hour of audio (.wav file in chunks OK)
  - Matching .lab files (.txt files readable by Prosodylab-Aligner) for each .wav file
  - A customized dictionary

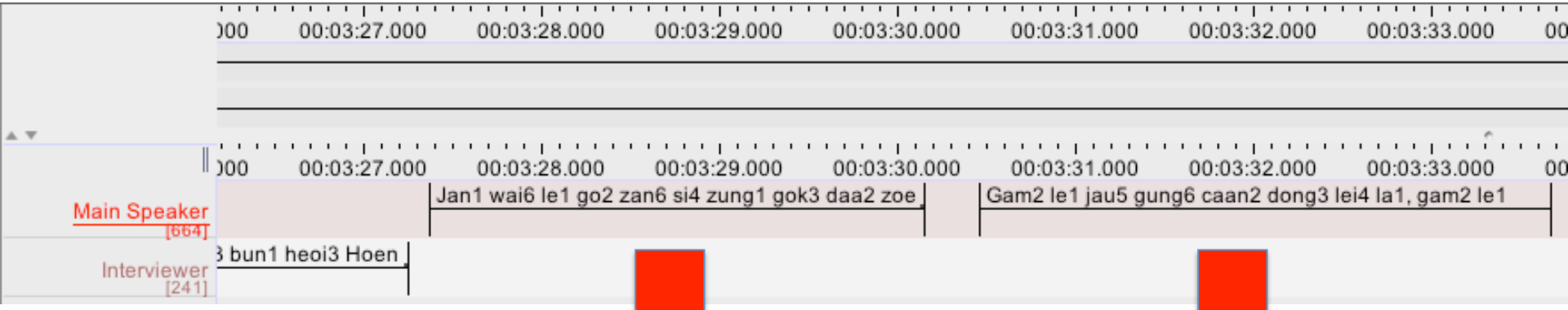
Methods – Cantonese Data

1. Interviews transcribed by native speakers of Cantonese using Jyutping Romanization in ELAN
   - Manual sentence-level alignment



2. To create input readable by Prosodylab-Aligner, PRAAT script used to create smaller .wav files with matching .txt files for each annotation.

PRAAT Script



C1F54A_IV_2074.wav

C1F54A_IV_2074.txt

Jan1 wai6 le1 go2 zan6 si4 zung1 gok3 daa2 zoeng3.

Translation: "Because at that time, China was at war."

C1F54A_IV_2105.txt

Gam2 le1 jau5 gung6 caan2 dong3 lei4 la1, gam2 le1

C1F54A_IV_2105.wav

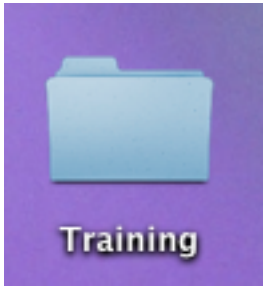
Translation: "And then the Communist Party came, and then ..."

Training and Evaluation

CAN_dict_4.txt

```
ZUNG3  Z U NG
ZUNG4  Z U NG
ZUNG5  Z U NG
ZUNG6  Z U NG
ZUT1  Z U T
ZUT2  Z U T
ZUT3  Z U T
ZUT4  Z U T
ZUT5  Z U T
ZUT6  Z U T
ZYU1  Z YU
ZYU2  Z YU
ZYU3  Z YU
ZYU4  Z YU
ZYU5  Z YU
ZYU6  Z YU
ZYUN1  Z YU N
ZYUN2  Z YU N
ZYUN3  Z YU N
ZYUN4  Z YU N
ZYUN5  Z YU N
ZYUN6  Z YU N
ZYUT1  Z YU T
ZYUT2  Z YU T
ZYUT3  Z YU T
ZYUT4  Z YU T
ZYUT5  Z YU T
ZYUT6  Z YU T
```

Custom dictionary in the format of The CMU Pronouncing Dictionary

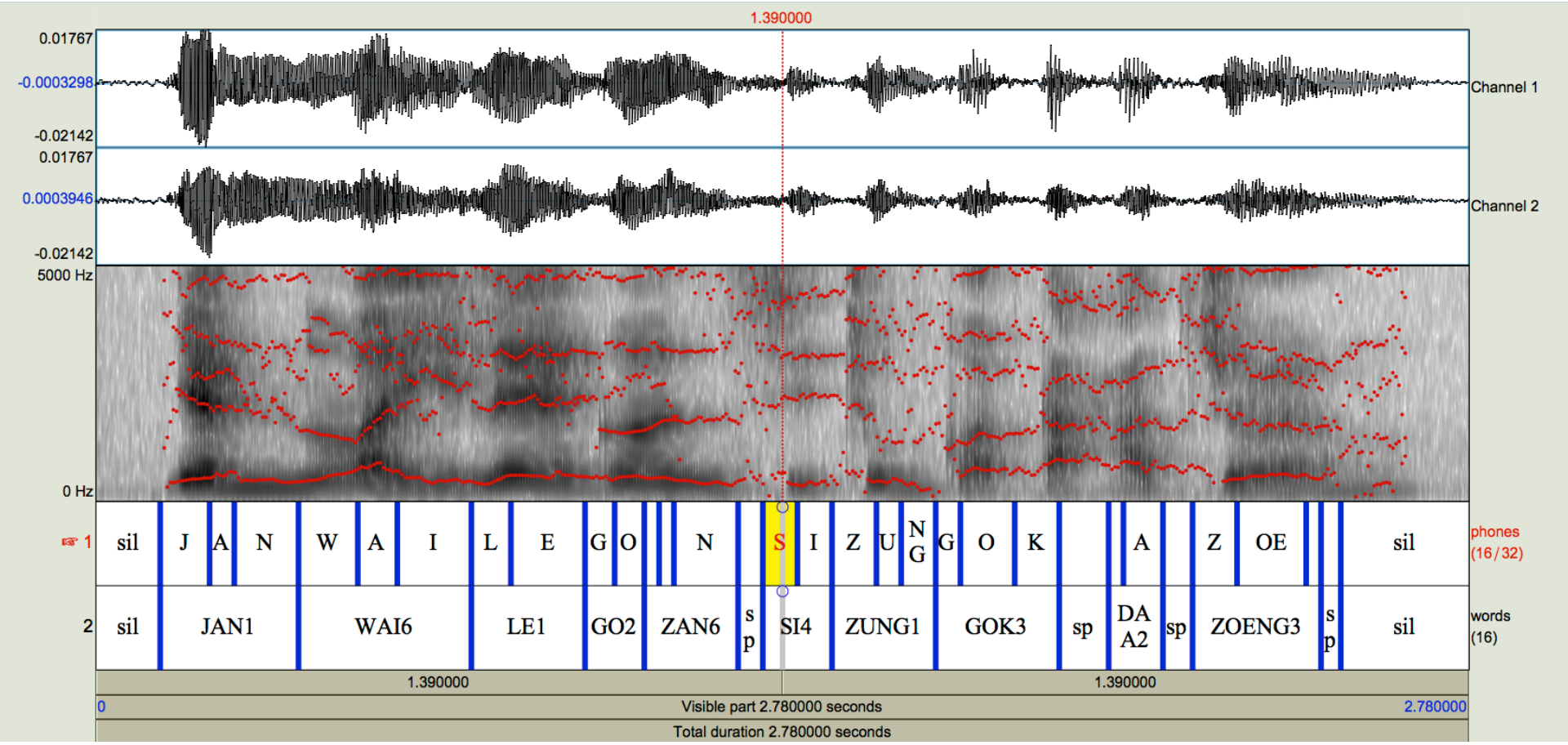


- .wav files and matching .lab files put in a Training directory

- Prosodylab-aligner uses Training directory and **dictionary** to build a training model

- **Prosodylab-aligner uses training model to evaluate the same files in the same directory**

Textgrid Output of Prosodylab-Aligner



Another PRAAT script: formant extraction

- Formant information extracted from Prosodylab-Aligner generated Textgrids and matching .wav files using PRAAT script
- Output: Tab-delimited .txt file

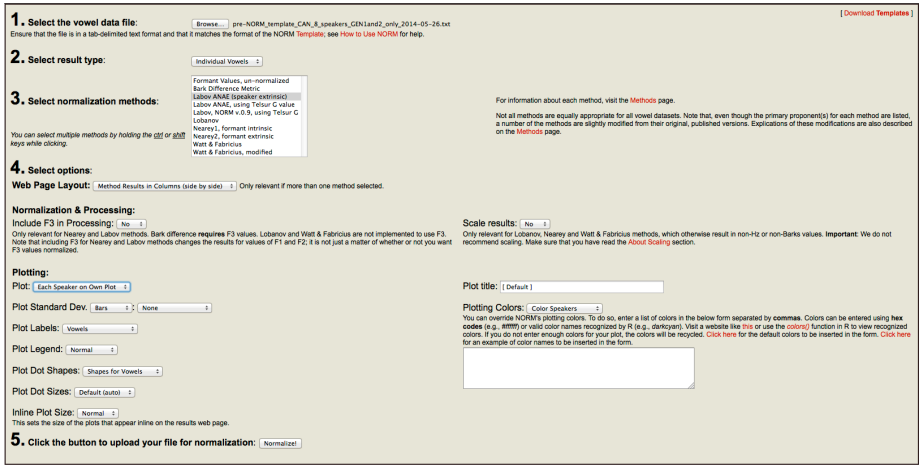
	A	B	C	D	E	F	G	H	I	J
1	Speaker	File	Vowel	F1	F2	Word	Tone	Length		
2	C1F54A	10035	A	225	1851	HAI	6	0.14		
3	C1F54A	10035	I	314	2006	HAI	6	0.09		
4	C1F54A	10035	A	557	2024	AH	3	0.03		
5	C1F54A	10035	I	413	1988	TEOI	3	0.04		
6	C1F54A	10035	A	718	1678	JAU	1	0.06		
7	C1F54A	10035	U	523	1579	JAU	1	0.05		
8	C1F54A	10035	A	635	1921	GAI	3	0.08		
9	C1F54A	10035	I	471	2032	GAI	3	0.05		
10	C1F54A	10035	AA	739	1422	WAAK	6	0.04		
11	C1F54A	10161	I	422	1904	ZEOI	3	0.08		
12	C1F54A	10161	E	463	2301	LEI	2	0.07		
13	C1F54A	10161	I	372	2388	LEI	2	0.11		
14	C1F54A	10161	O	487	1148	GO	2	0.07		
15	C1F54A	10161	AA	650	1489	FAAN	3	0.08		
16	C1F54A	10161	U	412	2413	GUNG	1	0.16		
17	C1F54A	10161	A	832	1845	AH	3	0.16		
18	C1F54A	10161	I	345	1829	ZEOI	3	0.09		
19	C1F54A	10161	U	463	1112	ZUNG	1	0.13		
20	C1F54A	10161	I	433	2340	JI	3	0.05		
21	C1F54A	10161	O	413	1440	ZOU	6	0.03		
22	C1F54A	10161	U	423	1183	ZOU	6	0.12		
23	C1F54A	10161	I	392	1889	ZEOI	3	0.1		
24	C1F54A	10161	E	418	2104	LEI	2	0.03		
25	C1F54A	10161	I	387	2228	LEI	2	0.11		

Vowel Normalization

NORM

The Vowel Normalization and Plotting Suite

- http://ncslaap.lib.ncsu.edu/tools/norm/norm1.php
- Labov ANAE (Vowel Extrinsic) method used



Prepping for R-Brul

- Tab-delimited .txt file generated by NORM with normalized values for vowel formants
- New columns added for variables
- Ready for statistical analysis with R-brul (Johnson)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Speaker	Vowel	Word	F1	F2	Generation	Sex	Age	Preceding	Following	Velar	Syllable	Tone
2	C1F54A	AA	BAAK6	857.44	1692.9	1	F	54	B	K	Yes	Closed	6
3	C1F54A	AA	BAAK6	815.52	1565.2	1	F	54	B	K	Yes	Closed	6
4	C1F54A	AA	BAAN1	821.51	1667	1	F	54	B	N	No	Closed	1
5	C1F54A	AA	BAAN1	818.51	1721.9	1	F	54	B	N	No	Closed	1
6	C1F54A	AA	BAAN3	815.52	965.24	1	F	54	B	N	No	Closed	3
7	C1F54A	AA	BAAN1	651.81	1606.1	1	F	54	B	N	No	Closed	1
8	C1F54A	AA	BAAN1	851.45	1546.2	1	F	54	B	N	No	Closed	1
9	C1F54A	AA	BAAN1	963.25	1518.2	1	F	54	B	N	No	Closed	1
10	C1F54A	AA	BAAN1	783.57	1394.5	1	F	54	B	N	No	Closed	1

Variables of Interest

- External Factors
  - Generation
  - Gender
  - Age
- Internal Factors
  - Following Segment
  - Tone

Cantonese Vowel Charts

Hong Kong Homeland CAN

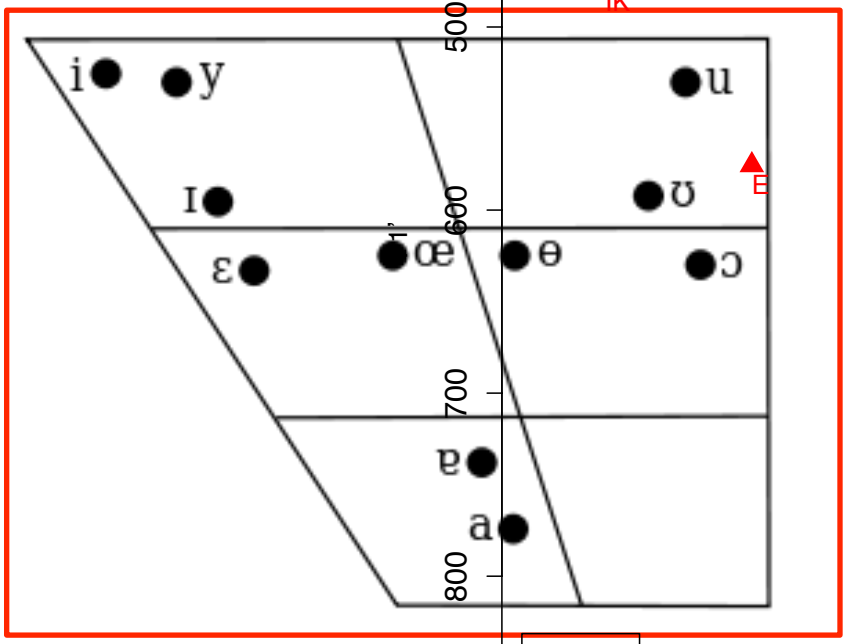
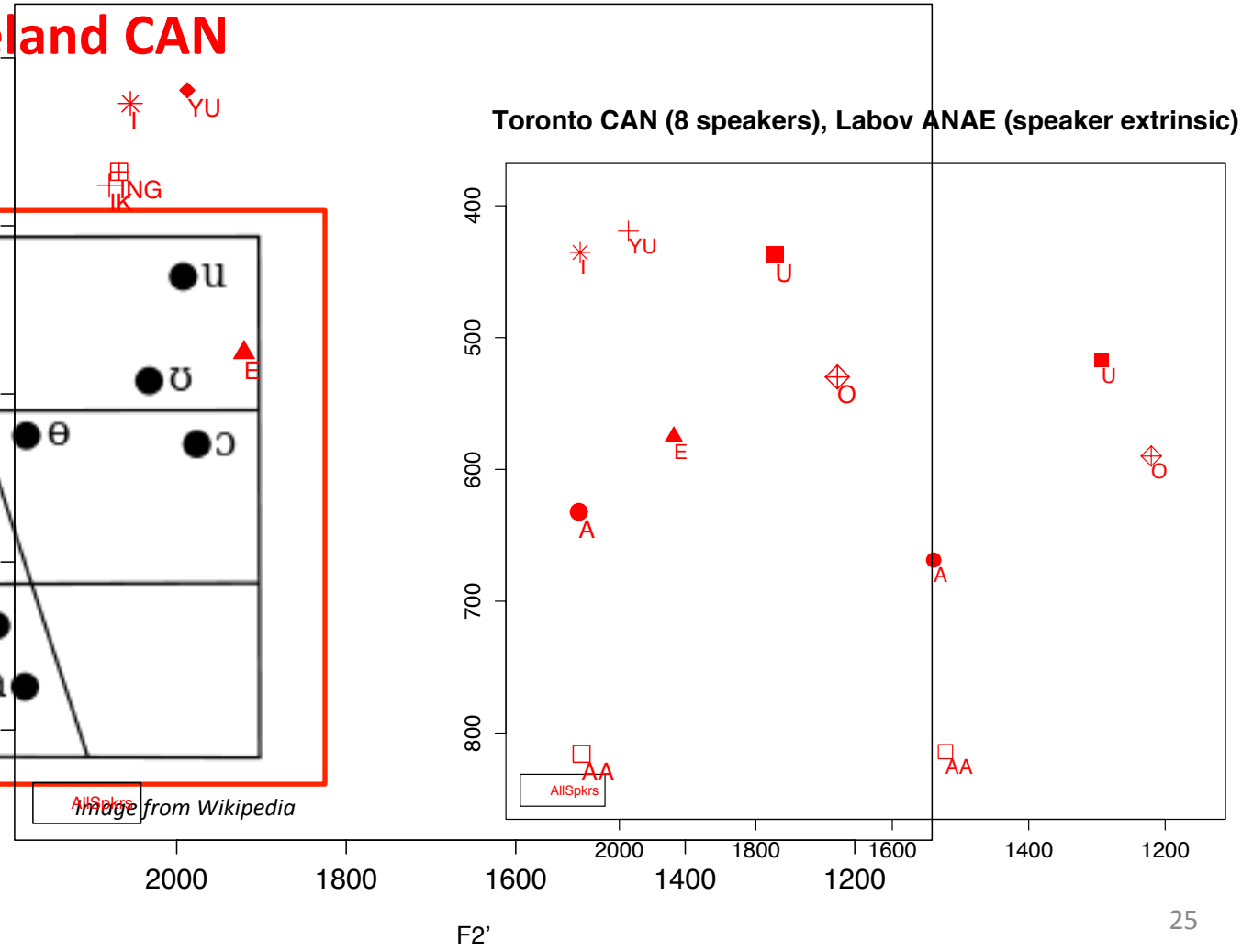
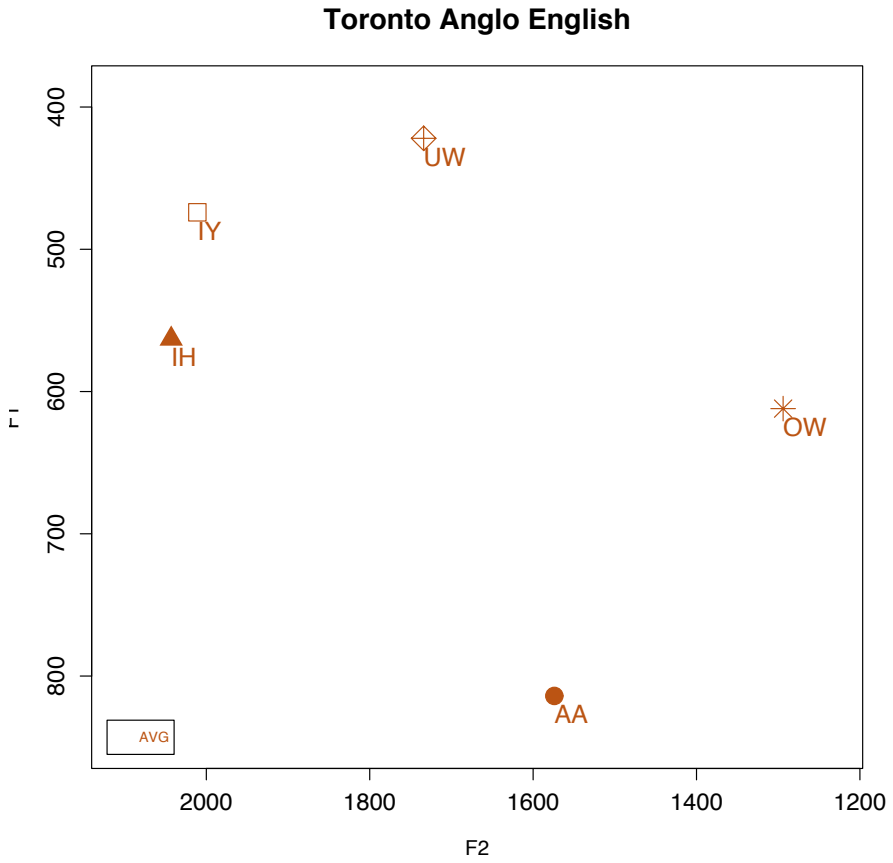
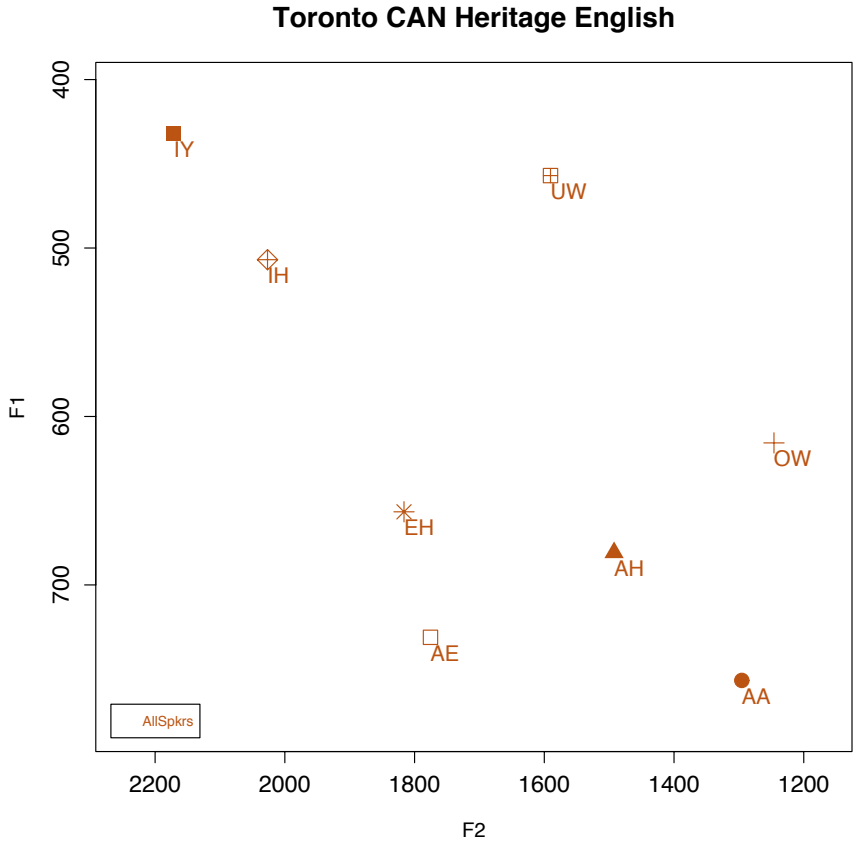


Image from Wikipedia



Toronto Anglo ENG vs CAN ENG

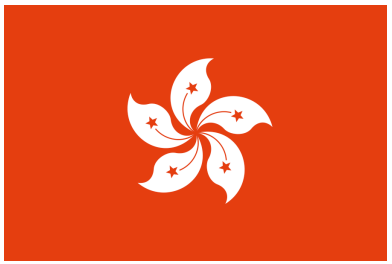




Based on means from Roeder 2012, Boberg 2008, Roeder & Jarmasz 2010

Based on means of 7 speakers

F1 and F2 Means for /i/ in open syllables



1st

2nd

Heritage Language / Culture → English/Canadian

Cantonese
(8 speakers)

Gen	F1*	F2*	Tokens
1	439	2044	3207
2	423	2106	857
All	435	2057	4064

•Gen 2 has higher and more fronted /i/
•*p < 0.05

CAN English
(11 speakers)

Gen	F1**	F2**	Tokens
1	454	2096	1545
2	434	2324	2370
All	441	2234	3925

•Gen 2 has higher and more fronted /i/
•**p < 0.01

Toronto Anglo English

F1	F2
474	2011

•Anglo English has the lowest /i/.

Discussion of Results

- Evidence of generational change clear with same general developmental trend in both languages.
  - Raising and fronting of /i/ for Gen 2 in both CAN and CAN ENG
- Relative position of /i/ and /ɪ/ are different in CAN and ENG.
- Lack of /u/ fronting in CAN observed, but some fronting in CAN ENG
- How these changes result from contact with English (if that is the case) appear to be quite complex
  - further research required to better understand how.
- Note
  - Tone not considered as a factor
  - Variation and change in other vowels not considered
  - No homeland data available

Discussion of Methodology

- Without human intervention, automatically extracted data creates reasonable vowel plots
- A promising avenue for future research on vowel variation and change in heritage languages
- But need to check and compare results with manual formant extraction

Future Work

- Assessing accuracy of automated alignment and formant extraction by attempting to replicate results using manual methods
- Expanding to more vowels and more speakers
  - 8 speakers for this analysis, ~ 40 CAN speakers in Corpus
  - Comparing homeland data
- Expanding to other heritage languages
  - Italian, Faetar, Russian, Ukrainian, Korean

감사합니다 Дякую Grazie molto Спасибо 多謝 gratsiə namuor:ə

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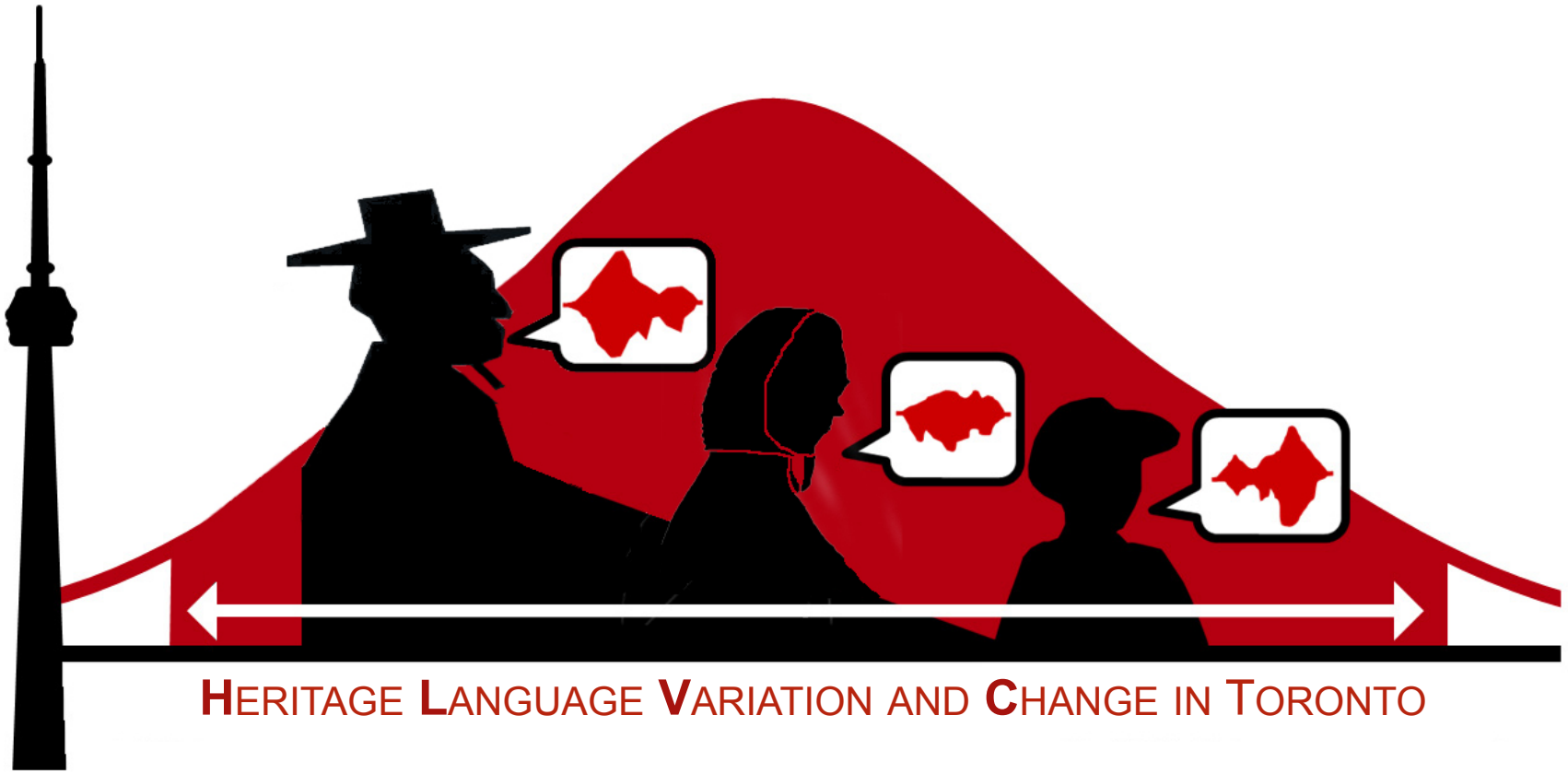

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